PLANT PROTECTION OVERSEAS REVIEW

JANUARY

1951

Vol. 2 No. 1

PLANT PROTECTION LTD

PLANT PROTECTION OVERSEAS REVIEW

A PERIODICAL SURVEY OF NEW DEVELOPMENTS IN THE CONTROL OF PESTS, DISEASES AND WEEDS

PUBLISHED BY

PLANT PROTECTION LTD

BOLTON HOUSE, 61 CURZON STREET, LONDON, W.1

VOL. 2 NO. 1 JANUARY, 1951

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EDITORIAL

IN this number, the first of volume II, we welcome two articles from our overseas readers on important problems connected with sugar cane cultivation. One article is on the subject of chemical weed control in this crop, which is receiving increased attention as time goes on wherever sugar cane is grown, and the other on the subject of the sugar cane froghopper and its control. Though this insect is a major pest only in Trinidad, its description and the means adopted for its control will, no doubt, be of interest to readers elsewhere and suggest ways of controlling major, and other, pests related, or of similar habit, to the Trinidad froghopper in their respective territories.

We publish in addition two articles contributed by members of the staff of Plant Protection Ltd. on cotton dusts and some agricultural and horticultural problems of Brazil respectively, subjects of great and immediate importance in the realm of plant protection in overseas countries.

We have also included a third series of " Technical Brevities", abstracted from published literature and other sources, which give useful information on plant protection problems in many parts of the world.

Although we have been favoured in this, and previous numbers, by contributions from readers abroad, we still look forward to receiving for publication further articles dealing with plant protection in all its aspects in as many countries as possible, contributed by writers with wide local experience of the problems involved.

THE SUGAR CANE FROGHOPPER

By T. E. K. POTTER

I. INTRODUCTION

THE Sugar Cane Froghopper of Trinidad—*Tomaspis saccharina* Dist., or more recently, *Aeneolamia varia saccharina* Dist. (1)-, is indigenous to Trinidad, where it is a serious pest of sugar cane. It is a member of the order Hemiptera, family Cercopidae, and whereas there are other members of this family which are being credited currently with being responsible for causing damage to sugar cane in British Guiana, Venezuela and some Central American Republics, there are none which have as yet attained the status of a major pest as has the Trinidad species.

The common name of this insect—*viz*. Froghopper—is descriptive of two phases of its life history, the first being its nymphal stage, for upon its emergence from the egg the nymphs excrete, and thereafter continue to live in, masses of spittle or froth of their own generation; this froth is not unlike that for which the toad — *Bufo agua*—locally referred to as a 'Frog' — is responsible, and in cases of severe nymphal infestation, the soil around the bases of cane stools is covered in these masses of spittle, resembling typical toad's (local 'frog's') froth. As an adult, the insect is a true 'hopper' in its manner of precipitate take-off for flights of short duration. The combination of these two characteristics was doubtlessly responsible for the derivation of the local name—'Froghopper.'

Although no specific investigation has been carried out in this respect, it appears to be widely accepted that the extremes of severity of damage resulting from Froghopper attacks on sugar cane can be correlated with the physiological condition of the crop at the time of the attack.

The responsibility for the damage is usually attributed to the adult, but it is by no means unlikely that the nymphs contribute largely, either on their own, or jointly with the adults, as a cause of the ultimate 'blight' of the cane plant. The term 'blight' is descriptive of a condition wherein the usually green leaves of the cane are brown, and the plant appears as though it had been scorched by fire; such a condition existing for only a relatively short period adversely affects the growth of the plant, and consequently the final yield.

The initial attack on the cane plant is by the Froghopper nymphs sucking the sap from the rootlets of the cane immediately below or on the surface of the soil and at the base of the stool ; it has been reported that such an attack alone can result in typical ' blighting ' of the cane. Subsequently, the adults invade the leaves, which they suck, at the same time injecting a saliva which is suspected of being toxic, resulting in the breakdown and necrosis of plant tissue extending over areas of the leaf out of all proportion to the physical injection. In severe infestations, the population of nymphs and adults per cane stool can exceed 200 of each, resulting in such a widespread damage as to warrant the statement :

> " Trinidad . . . has the unenviable distinction of possessing what may be regarded as the second worst insect pest in the world. . . the Froghopper is responsible in certain years for the loss of a greater proportion of a single country's production of a particular commodity than any other insect with the exception of the Cotton Boll Weevil." (2).

It is difficult to assess the loss of sugar resulting from uncontrolled Froghopper attacks in Trinidad, but it is the opinion of many responsible observers that the average annual loss can be estimated at 10 per cent of the total production, or roughly at 0.17 tons of sugar per acre. If this is at all accurate, the loss to the sugar industry would amount to 13,600 tons of sugar per year, or approximately $1,360,000 (Trinidad at $4.80 to £1 sterling) in value, at current prices.

Although the Trinidad species of Froghopper would appear to be specially adapted to local conditions, and has selected the sugar cane as a host plant preferable to the indigenous wild grasses, on account of the general similarity in life habits of allied species to *Tomaspis saccharina*, it behoves all sugar-producing countries to investigate methods of control of their species wherever a tendency is shown for them to invade sugar cane, or, for that matter, any other crop of economic importance.

II. LIFE HISTORY

Urich (3), Urich & Pickles (4) and Pickles (5) are the main contributors to our knowledge of the life history of the Trinidad Sugar Cane Froghopper. From these workers the following data are available :

> The female Froghopper lays on the average 50 eggs in her lifetime of approximately 10 days ; oviposition occurs in the soil at a depth of not more than 2-in. and within a radius of usually not more than 9-in. from the centre of the cane stool. As these eggs require conditions of high soil humidity for hatching and as there is a marked dry season in Trinidad during January to May, there is no activity in this period. After the commencement of the rains at the end of May, eggs which have aestivated since the end of the rainy season—extending from June to December— hatch, and give rise to what are referred to as ' first brood ' nymphs. The ' Froghopper Season ' therefore commences in June and ends in

December. Female adults from these ' first brood ' nymphs are responsible for the second generation only, but eggs laid thereafter by succeeding generations have a tendency to go into diapause, giving rise to what are termed ' long period eggs,' the accumulated total of which at the end of the season is responsible for the commencement of the attack in the following year. Records in a normal year show that there are four main periods of emergence during any one season, and for simplicity these are referred to as ' broods.' However, as egg emergences are dependent on climatic conditions, the differentiation of one brood from another is not always obvious.

The nymph undergoes four moults during a period of from 24—27 days, during which time it is enclosed in a mass of spittle or froth, generated by blowing air through a liquid secretion; this spittle serves as a protective shield as well as maintaining the nymph in a condition of high humidity. During this phase, the Froghopper is practically immobile, and is located on the surface of the soil in and immediately around the base of the cane stools, on the young rootlets of which it feeds. Metamorphosis from the last nymphal instar to adult occurs in the spittle case, after which the adult crawls up a cane shoot and hardens its wings in the air. During the hours of sunlight, adult Froghoppers shield themselves from direct rays in the apical sheath of cane leaves or funnel, emerging therefrom at dusk to feed on the cane leaves during the hours of darkness until dawn.

III. CONTROL INVESTIGATIONS

Since the recognition of the Froghopper as being responsible for sugar cane ' blight ' in the late 'nineties of the nineteenth century (6), many attempts have been made to control the pest. These have included, the encouragement of toads (*Bufo agua*), lizards and birds; the distribution of trap lights throughout fields; the dissemination of the spores of the Green Muscardine and *Empusa* fungi and the enlargement of foci of Syrphid flies and the study of egg parasites. Of all these biological methods of control the Syrphid fly nymph predator and the Green Muscardine fungus on the adult have effected on occasions a degree of control, but their practical effectiveness has been limited to defined climatic conditions.

On account of the failure of all known methods of biological control, early investigators turned to the use of Calcium Cyanide applied as a dust to the nymphs. Whereas the spittle mass was an excellent medium for the release of HCN, which effectively killed the nymph, the use of this powder only killed those nymphs with which it came in contact, and those that were under trash, etc. escaped; furthermore, to effect complete control of even one brood, several different applications were necessary, and this would have to be repeated for each new nymphal infestation, the final number rendering the method uneconomic if faithfully performed. Finally, the use of such a chemical in the close confines of a field of cane exposed the

workers to a definite poison hazard which was a serious objection to the method. Therefore, although this method was extensively used, it was at no time considered the answer to the problem.

In 1936 Pickles commenced investigations on the use of Pyrethrum against the adult insect. On account of the size of the established cane fields and the habit of the adult of being vulnerable only during the hours of night, he devised a method of drifting the insecticide across affected fields during night time, taking advantage of the light prevailing east to west winds which normally occur at that time during the rainy season. As Pyrethrum, at an economic dosage strength, did not effect a thorough kill of the adults, the method was never adopted for field usage, until the advent of DDT in 1943. A 5 per cent DDT dust applied by the ' drift dusting ' technique certainly resulted in a high mortality of adults, but on account of the configuration of the fields, and also the difficulties connected with the timing of the application if the method was to be effective and economic, the system was not adopted by the majority of estates. The substitution of a 5 per cent BHC dust—'Agrocide' 3 containing 0.65 per cent gamma BHC—did not materially improve control, due to the difficulty of timing the application for field usage. In 1947, trials were made with a Todd Insecticide Fog Applicator (TIFA), as it was hoped that if the insecticide were applied in oil, it might adhere more persistently to the leaf, thereby leaving a residue and so reduce the number of applications necessary to effect control; also the 'smoke' produced from TIFA might have a better penetrating power and so give a better coverage. Tests were performed with both DDT and BHC formulations unsuccessfully.

In the same year, on account of the reputation acquired by 'Gammexane' BHC formulations as a potent insecticide against soil inhabiting pests, a trial was made, using 'Agrocide' 2 and Liquid 'Agrocide' 3 as a pre-emergence application in a site in which it had been established that fertile Froghopper eggs were present. Results of this trial were so satisfactory in so far as the BHC dust formulation was concerned (7) that it was decided to continue on this line in the following year.

Accordingly, in 1948 a more elaborate trial was laid down to test the effect on Froghopper incidence of applications of a 4 per cent BHC 'Agrocide' at rates of 1 cwt., 3 cwts., and 6 cwts. per acre. Results obtained proved that first brood nymphs could be completely controlled by one application at as low a rate as 1 cwt. of a 4 per cent BHC dust per acre (8).

In the same year, the ' drift dusting ' technique was brought to its maximum effect by the testing of a helicopter in the distribution of the insecticide against the adults. Although perfect distribution of the dust was obtained by this means, the limitation of the measure as applicable to the ' drift dusting ' technique was the same. Timing of application against the adults on a field scale so as to effect control with a minimum of sorties requires a large, well trained and con-

scientious field staff, the expense of maintaining which, together with the operating cost of the helicopter, makes the system uneconomic.

Results corroborating those obtained by the application of a BHC formulation to the nymphs were obtained by an independent worker (2), the recommendation arising out of which was the application of 1—2 cwts. per acre of a 5 per cent BHC dust.

During the years 1948, 1949 and 1950 the method of attempted Froghopper control in the majority of affected areas in Trinidad was the application of from 1 to 2 cwts. per acre of a 4%—5% BHC dust to the nymphs. To be completely effective, observers have to be in operation throughout the estates from the onset of the rainy season, and as soon as nymphal infestations are reported in any fields, the application must be made. The actual application of the dust can be made by any satisfactory hand-operated dust distributor, but supervision is necessary to ensure that the insecticide is placed where it is most effective ; it is possible to apply the insecticide by hand, but this makes a more tedious and slower operation.

As no expensive equipment is necessary, such a control method is within the economic limit of the cane farmers (peasants), who cultivate nearly 50 per cent of the total cane acreage.

To reduce the cost of the insecticide, a concentrated BHC formulation ('Agrocide' 10, containing 50 per cent BHC) is imported and diluted with locally-produced ground limestone, to make a 4% or 5% BHC product, the cost of which is in the region of three cents per lb.

There are indications suggesting that a field treated in such a manner in one year will be free from Froghopper infestation for at least the following year. If this is established the cost of treatment will be halved, which will make the method even more satisfactory. Similarly, it may be possible to apply the insecticide as soon as the cane is reaped, in which case a mechanical applicator could be used, which would further reduce the cost.

In conclusion, it may be stated that the Trinidad Sugar Cane Froghopper can be successfully and economically controlled by the application of 1—2 cwts. per acre of a 4%—5% BHC dust to the first brood nymphs. It is possible that an even more satisfactory method may be determined in the future, especially if an efficient ovicide is discovered, whereby the Froghopper eggs can be killed in the soil, but it is believed that for the present, at least, the above described measures can control this most important pest.

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THE CONTROL OF WEEDS WITH SELECTIVE SYNTHETIC HERBICIDES IN THE COLONY OF MAURITIUS

By Dr. H. EVANS

INTRODUCTION

MAURITIUS, an island of 720 square miles, including its immediate dependencies, produces 400,000 tons of sugar from the 140,000 acres or so suitable for economic cane production. The population of 450,000 people is predominantly dependent on sugar exports—sugar producing about 97 per cent of the total revenue.

It is natural, therefore, that since control of weeds is an important item in sugar production costs, early attention to modern methods of weed control has been a major line of research for some years in the colony's Sugar-cane Research Station.

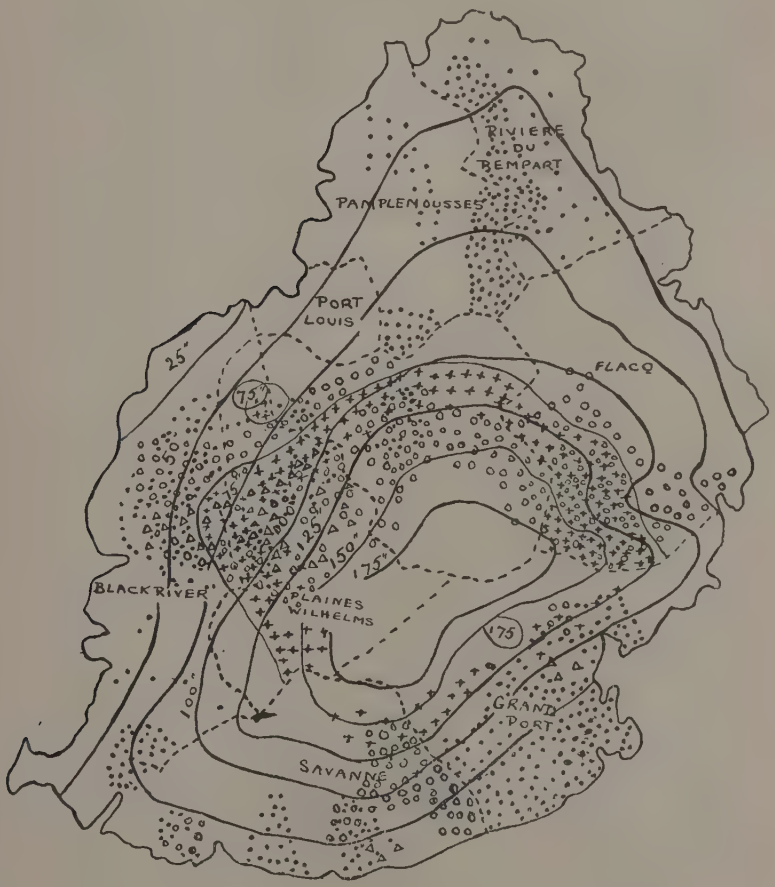
Most of the pre-war work was based on the use of sodium chlorate, copper salts and mechanical control since selective synthetic hormone type herbicides were not then available.

Great impetus was given to the investigations on weed control by the excessive encroachment of weeds into arable land during the war years, when a total of 27½ per cent of the sugar area was obligatorily placed under food crops. The attendant shortage of labour and lack of mechanization methods for food crops resulted in a very serious weed problem when such areas reverted to cane production.

The situation was complicated by the fact that the presence of abundant basaltic rock both above and below the ground rendered the use of mechanical methods impracticable over large areas.

Through the courtesy of Messrs. Plant Protection Ltd., supplies of methyl-chloro-phenoxy-acetic acid as liquid 'Agroxone' and 1% dust were made available at an early date. Later, supplies of dichloro-phenoxy-acetic acid became available and by the end of 1946 a considerable amount of information on the value of these herbicides on the most important weed species was available. Preparations for a drive against weeds had been made during the war years by instituting a thorough ecological survey of the weed flora in all the cultivated

areas of the island. The extent of the problem and the weed species concerned were thus intimately known when the selective herbicides became available. This information was of tremendous value in framing the details of the investigation into the reactions of the most important weed species in the different ecological areas.



MAP OF MAURITIUS showing distribution of:

+ "Herbe Bol" or "Tam Tam" (*Hydrocotyle bonariensis*).
○ "Brède Chinois" (*Artemisia vulgaris*).
△ "Herbe Solférino" (*Ambrosia artemisiifolia*).
• "Liane Lingue" (*Paederia foetida*).

TEXT FIG. 1

THE WEED FLORA OF MAURITIUS

Environmental conditions differ markedly within relatively small areas in Mauritius : rainfall varies from 25—30 inches in the dry leeward areas to 150 inches or more in the wet uplands. Sugar-cane is generally not grown without irrigation unless the rainfall is at least 60 inches per annum. There are considerable differences in temperature also between the lowlands and the wet uplands and chiefly as a result of these factors the soil characteristics vary from rocky soils of low degree laterization to highly laterized free soils where considerable leaching has occurred. It is thus not surprising that the weed flora is numerous in species.

The present paper will be confined to those species which are effectively controlled by MCPA and DCPA* although considerable success was achieved in the control of Gramineous and other weeds resistant to the hormone type herbicides, by the use of non-selective herbicides. The ecological weed survey had shown that certain susceptible noxious weeds occurred in large areas as the dominant weed, and in many cases as almost pure stands. Attention was concentrated on these weeds in the first instance. The three most important species are *Hydrocotyle bonariensis*, an Umbelliferous weed with an extensive rhizome system, *Artemisia vulgaris* and *Ambrosia artemisiifolia*—both rhizomatous Composite perennials.

The distribution of these weeds in Mauritius are shown in text figure 1. Quadrats of 1 square metre were selected in the regions where these weeds were most troublesome, and the aerial and subterannean portions of the plants separated. From calculations made from such quadrats the following data were derived : they are expressed as weights per acre.

Hydrocotyle bonariensis

Fresh weight of aerial portions	13 tons
Fresh weight of subterranean portions	22 tons
Total fresh matter	35 tons
Dry matter	3.7 tons

Nitrogen content (per cent dry matter): Leaves 2.12-3.32, Rhizomes 1.12-1.80

K_2O	„	3.58-4.80,	„ 2.30-3.30
P_2O_5	„	0.91-1.22,	„ 0.84-0.89

It was calculated that this weed was locking up 170 lb. of Nitrogen, 200 lb. of K_2O and 75 lb. of P_2O_5 per acre.

Artemisia vulgaris

	Fresh weight	*Dry weight*
Aerial shoots	9.7 tons	1.16 tons
Subterranean organs	13.6 tons	3.63 tons
Total	23.3 tons	4.79 tons

Nitrogen content (% dry matter)	Tops	1.76%	Rhizomes 0.52%
K_2O	„	2.27%	„ 1.73%
P_2O_5	„	0.63%	„ 0.45%

Total quantities contained in the weed were approximately 80 lb. Nitrogen, 180 lb. K_2O, 47 lb. P_2O_5.

* Methyl-chloro-phenoxy-acetic acid, and 2-4 Dichloro-phenoxy-acetic acid.

RESULTS OF INVESTIGATIONS WITH MCPA and DCPA

Preliminary tests indicated that *Hydrocotyle bonariensis* was extremely susceptible to these herbicides, yellowing and death of the leaves resulting from spraying with a solution containing as little as 0.025% active substance ($\frac{1}{4}$ lb. active acid per acre). The rhizomes, however, survive this concentration and for effective kill of the rhizomes two applications of 0.1% active substance is necessary at a spraying rate of 80—100 gallons per acre.

Some interesting data were obtained on the effect of climatic factors on the efficacy of herbicidal sprays on this weed. It was established that whereas the direct effect of the herbicide as shown by the time required for yellowing and defoliation was greater in the summer months the degree of eradication obtained was higher in the cooler months. It was shown by tests using the germination of radish seeds as a criterion of persistence that most of the herbicide was decomposed within 10—14 days in the summer months as compared to 4—5 weeks in the winter months.

Portions of rhizomes to which the herbicide is not translocated may escape damage with one application in the summer months and new leaves produced from such segments of rhizome do not show subsequent yellowing. In the winter months there is sufficient herbicide left for root absorption to deal with such new growth. In sugar-cane fields in Mauritius the trash, or dead cane leaves, is deposited on alternate interlines. Growth of Hydrocotyle is more luxurious on the trash interlines and the weed is more difficult to kill owing to the increased length and depth of the rhizomes, which increases the distance that the herbicide has to be translocated to reach all viable parts of the rhizome. Experience showed also that results were often not fully satisfactory when rain fell soon after the application was made. An interesting interaction between the type of chemical used and incidence of rain after application was established.

A controlled experiment with three replications was carried out in which a rainfall of half-inch was produced with watering cans at stated intervals after application. The rate of application was 1 lb. active acid per acre (applied in 100 gallons water). Effectiveness of the applications were measured by the percentage of leaves killed by the treatments (only the leaves of this weed appear above ground, the stems being subterranean). The results are summarized in the table on next page.

Numerous other experiments showed that the sodium salt of DCPA was particularly ineffective when rain fell soon after the applications were made. The reason why the ammonium salt should be so much more effective under these conditions is obscure. Other formulations of DCPA in oil emulsions, particularly the isopropyl ester and a proprietary ethyl ester, retain their effectiveness relatively undiminished when rain falls soon after application is completed. Under favourable weather conditions, *i.e.* bright sunshine with no rain for at least 24—48 hours after making the application, there were no significant

	% leaves killed by :—		
	DCPA ammonium salt	MCPA 'Agroxone' (liquid)	DCPA sodium salt
No rain	100	95	90
¼ in. rainfall after 20 hrs.	100	90	80
¼ in. „ „ 4 hrs.	95	80	65
¼ in. „ „ 1½ hrs.	85	65	40
¼ in. „ „ ½ hr.	75	40	10

differences between the different formulations for this particular weed. Dust forms of MCPA and DCPA were considerably less effective against *Hydrocotyle bonariensis* than all the liquid sprays at equivalent concentrations.

Following the demonstration of the effectiveness of DCPA and MCPA against this weed, planters became increasingly interested and within a year the weed had been eradicated from over 3,000 acres of infested land in spite of the difficulty of obtaining adequate spraying equipment. The results of practical spraying on a large scale confirmed the experimental findings that the optimum dosage for complete control was two applications each of 1 lb. active acid per acre. There are no extensive areas of this weed left on cultivated land and the cost of complete eradication has been only a fraction of the annual recurrent cost of keeping it in check.

Artemisia vulgaris is considerably more resistant to MCPA and DCPA than *Hydrocotyle bonariensis*. The aerial shoots succumb readily but there is generally some regrowth from the dense matrix of rhizomes which permeate the top 12—18 inches of soil.

For complete eradication, 10% sodium chlorate is fully effective, but as sodium chlorate at this strength cannot be used in growing cane plantations, it is preferable to use DCPA or MCPA at 2 lb. per acre and to leave the growing cane to complete eradication. This technique is frequently the most economic procedure in sugar-cane. This crop is, in fact, an excellent smother crop providing that it achieves dominance in the early stages. Experiments showed that *Artemisia vulgaris* was considerably more susceptible to MCPA or DCPA when growing in the shade and when growing in soils rich in nitrogen or following an application of nitrogenous fertilizer. One to two applications of 2 lb. per acre is usually adequate completely to suppress this weed in cane plantations.

Ambrosia artemisiifolia, known in America as Ragweed, occurs in large areas in the rocky, gravelly soils of the intermediate rainfall districts. It is reputed to have a particularly depressing effect on cane growth and has an extensive rhizome system. Ester formulations of

DCPA are more effective than water soluble forms and eradication is secured under favourable weather conditions with one application of 2 lb. per acre active acid. From 3 to 3½ lb. per acre of the sodium salt of DCPA may be necessary to produce the same result.

In 1948 an enterprising young Mauritian set up in business as a weed control contractor. His equipment was fully engaged for many months in fulfilling contracts for the control of *Ambrosia artemisiifolia*. In addition all the large estates have their own herbicidal outfits.

Paederia foetida. This stink-vine is a particularly noxious weed in the rocky parts of the island where stone walls exist between cane rows. The rocky unweathered volcanic basalt has been removed from the soil over large areas of the cane tract, the practice being to line the rock in the cane interlines. At the end of each cane rotation (every 7—8 years) the 'walls' have to be pulled down and re-erected on account of infestation with weeds, particularly *Paederia foetida* and climbers of similar habit. *Paederia foetida* would quickly strangle the adjacent cane if left to grow and the cost of control is remarkably heavy. The leaves are susceptible to the hormone herbicides: the difficulty is in killing the extensive stem which permeates the walls for several yards. The problem was one of introducing enough herbicidal material through a relatively small leaf surface into a vast stem system containing large quantities of carbohydrate reserves.

The best and in fact the only effective treatment for this weed is to spray with a solution of the isopropyl ester of DCPA in Diesel oil or other mineral oil of high aromatic content. The ester is used at a concentration of about 0.5% active acid. Even after this treatment some regrowth may occur, which is controlled by subsequent spot spraying. In spite of the relatively high cost of this treatment it is economically profitable as the cost of 'relieving walls' is now prohibitive.

Cyperus rotundus. The cosmopolitan Nutgrass is extensively distributed in Mauritius as in most other tropical countries. The effects of DCPA and MCPA on this weed have been reported from many countries, the results being often very contradictory. There is little doubt that many investigators on the reactions of this weed published their results prematurely and claimed eradication when viable corms were still present. During the hot wet months, one plant of *C. rotundus* may give rise to 90—100 new corms. Many of these may remain dormant until the soil is cultivated or otherwise disturbed when an abundance of green shoots appear. Experiments in Mauritius showed that repeated applications were necessary for complete eradication and that it was more effective to aim at suppression rather than complete eradication. A complete kill of aerial shoots and the tubers at the base of the shoots may be obtained with as little as 1—1½ lb. per acre of MCPA or DCPA. The policy successfully followed in Mauritius was to control this weed in the cane furrows to eliminate competition with the young growing cane shoots and to treat the interlines at longer intervals with the hoe.

It is of interest that the average planter in Mauritius regards Nutgrass as an indicator plant for good soils. The probable reason for this is that heavily manured land is always highly infested on account of the dispersal of viable corms in the manure. Field trials showed that this weed competed heavily for moisture with young cane in the drier districts. In plots in which *Cyperus rotundus* was the dominant weed, unweeded cane of 3—4 months old died out through drought during the dry months. In plots given the usual routine cultivations, the young canes showed curling leaves and signs of moisture deficit, whereas in plots clean weeded with MCPA and DCPA there were no signs of water stress.

Extended observations in fact showed that although weed growth and weeding bills were considerably less in the dry districts than in the high rainfall districts, the deleterious effects of weeds were relatively greater in the dry districts. In the wet districts competition is mainly for nutrients, particularly Nitrogen, and to a lesser degree for light, whereas in the dry districts it is chiefly for water and to a lesser extent for Nitrogen.

Lantana Camara. This shrubby weed, which used to be a prominent weed until the importation and subsequent dispersal of the Black Sage (*Cordia macrostachya*) ousted it from its typical habitat, exists in Mauritius in two forms which are botanically listed as two varieties. The two forms have pink and orange flowers respectively. These two forms were shown to illustrate 'par excellence' the selectivity of the hormone type herbicide. The pink flowered form is easily killed by one application of 1½—2 lb. per acre of MCPA or DCPA, whereas under the most favourable conditions the lethal dosage for the orange flowered form is 5 lb. per acre active acid.

Cordia macrostachya or Black Sage. This weed spread like wild-fire in Mauritius during the last decade. Although susceptible to damage by selective herbicides, it was not possible to control the weed economically by this means. Non-selective weed killers, such as ammonium sulphamate and sodium chlorate, although effective at high concentrations, were not economic. Fortunately, this weed is now being satisfactorily controlled by biological means following the importation of insect pests despatched by the Commonwealth Bureau of Biological Control from Trinidad. From the biological viewpoint Black Sage is of interest in that it illustrates in a decisive manner the varying formative effects of applications of selective herbicides at different levels.

Large, but sub-lethal dosages, results in the formation of palmate or even compound leaves : smaller dosages produce the narrow strap shaped leaves chlorotic at the centre with dark green fluted edges typical of hormone damage in many other types.

Alocasia macrorhyza. This aroid is an important weed in the wet districts and along irrigation canals in the dry districts. The epinasty and yellowing of the leaves is very striking when treated with selective

herbicides. Dwarf leaves generally emerge from the root stock and rhizomes after one spray treatment : two applications generally result in satisfactory suppression.

When growing in very wet soil this weed, like many others, is more resistant to herbicidal treatment and the destruction of such communities is more readily achieved by use of the isopropyl ester of DCPA in Diesel oil.

OTHER WEEDS ESTABLISHED AS DISTINCT COMMUNITIES IN RESTRICTED LOCALITIES

Other troublesome weeds which have been effectively controlled with synthetic hormone herbicides in localized areas include the following :—

Tridax procumbens. Frequently occurring in communities of several acres in the dry areas of the North and West of the island. Completely controlled by 2 lb. per acre DCPA or MCPA ; 1 lb. per acre results in 70—80% control.

Hydrocotyle asiatica and *H. sibthorpioides* are somewhat more resistant than the more noxious *H. bonariensis* referred to earlier in this report, but are controlled by two applications of 2 lb. per acre : in the case of *H. sibthorpioides* one application may be sufficient under favourable conditions.

Parthenium hysterophorous. A seasonal but important weed of the dry and medium rainfall areas. It is killed in its young stages by a single application of 1 lb. per acre : fully grown plants require 2—2½ lb., and this application inhibits seed germination for two months or more.

Asystasia gangetica is completely controlled by 1 to 1½ lb. per acre MCPA or DCPA.

Striga hirsuta, the only *Striga* root parasite existing in Mauritius, is eradicated by one application of 1½—2 lb. per acre.

Other annual and perennial weeds generally dominating the weed community at some time or other during the year which are controlled or suppressed by synthetic selective weed killers include the cosmopolitan *Bidens pilosa*, *Plantago lanceolata*, *Cynoglossum rochellia*, *Ipomea coccinea* and *I. cairica*, *Cuscuta reflexa* and other *Cuscuta* spp., *Ageratum conyzoides*, *Conyza linearioloba*, *Lactuca* and *Sonchus* spp., *Siegesbeckia orientalis*, *Verbena* spp., *Medicago*, *Melilotus* and *Vicia* spp., *Oxalis* spp., *Alternanthera sessilis*, *Amaranthus caudatus*, *Argemone mexicana*, *Commelyna* spp., etc.

SPECIAL PROBLEMS OF MIXED WEED COMMUNITIES

In the drier parts of the island, Bermuda grass, *Cynodon dactylon*, is a serious pest. It is often a constituent of mixed weed communities and the eradication of the more susceptible weeds by means of selective herbicides results in colonization of the treated area by the surviving Bermuda grass. Combinations of selective herbicides with the DNOC

(Dinitro-ortho-cresol) compounds in such herbicides as ' Denoxylon ' were ineffective. The writer, however, compounded a general purpose herbicide to which liquid 'Agroxone ' or the ammonium salt of DCPA were compatible. This compounded herbicide has the following formula :

A { 80 grams ammonium DNOC, 80 grams ammonium sulphamate } dissolved in 400 c.c. water

B { 80 grams sodium chlorate, 12 grams sodium arsenite } dissolved in 400 c.c. water

A and B are mixed and to the mixture 200 c.c. of a 1:1 emulsion of Diesel oil and water—emulsified with 50 grams "Teepol" is added.

The mixture is diluted x20 to x50 with water according to the nature of the weeds and the necessary quantity of liquid 'Agroxone' or ammonium DCPA added to give a 0.1% or 0.2% concentration of active acid.

This mixture killed the above ground parts of weeds such as *Cynodon dactylon* and other grasses, *Euphorbia* spp., *Mimosa pudica* and other plants resistant to selective weed killers whilst at the same time retaining the herbicidal properties of the hormone herbicides against susceptible species of the weed flora. Such a procedure inhibits colonization by resistant weed species since it acts also as a contact herbicide against all weeds.

Compound herbicides have been extensively used in chemical weeding of sugar-cane in the Hawaiian islands—mostly based on sodium pentachlorophenate, sodium arsenite and sodium chlorate. The compound herbicide described above compared favourably in its results with Hawaiian formulae and was considerably cheaper to make up in Mauritius than the chemicals utilized in Hawaii.

INFLUENCE OF SELECTIVE WEED KILLERS ON SUGAR CANE AND MAIZE

Comparative trials were made of the effect of increasing dosages of ammonium DCPA and of MCPA as liquid 'Agroxone' on the sugar-cane variety M134/32, which forms over 80% of the total area in sugar-cane in Mauritius. These trials showed conclusively that ammonium DCPA was considerably more toxic to sugar-cane than MCPA. Dosages up to 3 lb. per acre produced no noticeable injury apart from a temporary cessation and reduction of terminal growth which lasted for about two weeks after which growth was normal. This temporary reduction in cane growth had been recorded in field trials with young cane plants, particularly when sprayed in hot, dry weather.

With dosages of 3—5 lb. per acre, red pigmentation developed at the tip of the spindle and the margins of expanded leaves : frequently the pigmented areas die. With dosages of 5—10 lb. per acre, some chlorotic lesions were produced on the young leaves and the leaf sheaths clasped the stem more tightly. This is due to a swelling of the

nodal tissues resulting in the root primordia being carried outwards as a thick ring of purple coloured tissue. The epidermis frequently failed to keep pace with the growth of the underlying tissues resulting in its becoming detached : at this stage the epidermis could easily be peeled off. Some damage was also apparent in the meristematic region of the growth ring, which commenced as a purple pigmentation followed by necrosis. The more serious type of damage was only produced by ammonium DCPA at the higher concentrations. Liquid MCPA ('Agroxone') did very little damage to the cane even at a concentration of 1% active acid (10 lb. per acre). It is difficult to avoid the conclusion that ammonium DCPA is somewhat less selective than MCPA. The dosage of selective herbicides normally employed in sugar-cane plantations (up to 5 lb. per acre) is not likely to result in any significant damage to sugar cane.

Maize. Maize was found to be more susceptible to damage under Mauritius conditions : even 1—1½ lb. per acre may cause marked stem curvature and abnormal development of root primordia. If the maize is treated in the early stages of growth little or no damage resulted ; most of the abnormal development takes place when the plants are growing rapidly. The damage does not seem to be serious enough to preclude the use of selective herbicides in maize plantations.

PRE-EMERGENCE WEED CONTROL

Pre-emergence weed control has not been as widely practised in Mauritius as in certain other tropical territories owing to the difficulty of mechanical cultivation over large areas. However, during the last few years mechanical rock removal has been extended in most areas where the quantity of surface rock is not excessive. In these instances and in the free soils of the humid districts where mechanical cultivation is possible and the preparation of a seed bed of good tilth easily accomplished, there is undoubtedly scope for the use of pre-emergence applications of herbicides.

The writer has studied the application of pre-emergence weed control in Trinidad—such application is now standard practice on most of the large sugar estates and there is no question that the procedure is very effective. It has the great advantage that germination of Gramineous seedlings and other species resistant at a later stage is inhibited, thus resulting in a great measure of freedom from weeds.

Once the serious perennial weeds have been eradicated it would seem that pre-emergence applications followed by later applications designed to treat the weeds whilst they are in the young seedling stage is the logical method of chemical weed control in sugar-cane plantations. A well prepared seed bed and maintenance of good tilth is necessary to obtain the best results.

SOME AGRICULTURAL AND HORTICULTURAL PROBLEMS IN BRAZIL

By D. A. TIDMAN

INTRODUCTION

Brazil, the largest autonomous country in the tropics, and the fourth largest country in the world (8,500,000 square kilometres in extent) extends from the Tropic of Capricorn to the Equator. Only the states of Rio Grande do Sul, Santa Catarina and Parana in the extreme south, and a small portion of São Paulo, lie below the tropics.

Apart from having the largest cattle population of any South American country, rural products sustain most of Brazil's population and directly provide a living for more than two-thirds of it. Agricultural output is insufficient for domestic needs and on that account exports of many crops, of which there is a shortage, have been restricted. Due to the extreme range of climatic conditions, Brazil can show a very good representative selection of world crops, and problems in the pest control sphere are many and diverse.

COCOA

Azteca paraensis var. *bondari* is the worst cocoa pest and forest insect in the State of Bahia. It lives in symbiotic association with the epiphytic plants *Codonanthe formicarum*, *Epidendrum immatophyllum* and *Coryanthes maculata*. It also nurses and protects *Pseudococcus citri* and many other undetermined scale insects. This ant invariably incorporates the epiphyte in its nest, and gnaws the pods and shoots of the cocoa to obtain material for building construction. The epiphytes themselves prevent the cocoa flowers from opening and at the same time interfere seriously with the normal physiological functions of the tree. *Pseudococcus citri* weakens the tree by continuous sap-sucking. It is apparent that this complex of ant, epiphyte and sap-sucker is a most serious problem to the cocoa planter.

During the years 1944/46 the Instituto de Cacao de Bahia sponsored a campaign to control this ant, and the method used was to cut off the affected limbs of the trees. No fewer than 10,000,000 nests were destroyed in this manner, and, in the opinion of the writer, as much damage was caused by the treatment as by the ants.

The ' cacarema ant ' (*Azteca chartifex*) is almost as important, and is widespread throughout all the cocoa plantations, and lives in symbiotic association with aphids and scale and mealy bugs, and seems to live entirely off the honeydew secreted by these insects. It also gnaws and damages the pods and shoots of the cocoa tree from which it obtains the material for its nest.

The ' pichicheca ' or Fire Ants (*Solenopsis*), attend the mealy bug (*Pseudococcus citri*). *Pseudococcus citri* usually congregates in large numbers on the developing pod, which ultimately cracks and splits in all directions. Here again, *Solenopsis* seems to feed exclusively on honeydew. Indirectly it is a troublesome pest in the picking season, for its bite is so painful that operators frequently refuse to pick fruit from a tree inhabited by this ant.

Crematogaster magnifica, or Acrobat Ant, is a similar pest, nursing scales and mealy bugs and damaging the wood and pods by gnawing.

With all these arboreal species it should be noted that, not only are affected trees (which number millions) seriously weakened, but about 10% die each year from this complex.

The destruction of the epiphytes without damaging the cocoa tree is a difficult problem, but it has been suggested that small scale trials be carried out using ' Fosferno ' Liquid (20% parathion) against the ants, directing the spray so as thoroughly to wet the nests, which are open and porous, and the tree as a whole.

Cocoa has its full complement of coccids, and Pedrito Silva, Chief of the Plant Pathology Section of the Cacao Experimental Station, records :—

Pseudaonidia trilobitiformis Green.
Coccus viridis Green.
Ceroplastodes bahiensis
Ceroplastodes costa-limae
Ceroplastodes melzeri
Ceroplastodes theobromae
} New species in trophobiosis with *Azteca chartifex* var. *spiriti*.
Aspidiotus destructor Sign
Aspidiotus cyanophylli Sign
Saissetia hurae Bondar
Pseudococcus citri Risso.

For the control of the above it has been suggested 'Albolineum' 1 be used at a concentration of 2 litres per 100 litres, with or without the addition of 150 c.c. ' Fosferno ' Liquid. From observations in the State of Rio de Janeiro this combination gives excellent control of coccids.

FUNGI. The main fungal organisms attacking cocoa are :—

Diplodia theobromae Nowell (Black Pod Rot) on fruit,
Phytophthora palmivora Butler (Brown Pod Rot) on fruit and branches,
Corticium salmonicolor Bet Be (Pink Disease) on stems,
Corticium stevensii Bet Be on leaves,
Marasmius spp. (Thread Blight) on branches,
Polyporus spp. (Wood's Ears) on trunks.

The most destructive of these fungi is *Phytophthora palmivora*, which causes a crop loss annually in excess of 10%. The control measures to date include thinning of the overhead shade, drainage of the swamp lands, and spraying with 1% Bordeaux Mixture.

Bordeaux Mixture does not seem to give outstanding results and other forms of copper should be tried at :

	AS " PERENOX "
Diplodia theobromae	150—200 grams./100 litres.
Phytophthora palmivora ...	250—500 „ „ „
Corticium salmonicolor... ...	200—400 „ „ „

Due to the close-growing formation of cocoa trees, and the continual shedding of dead leaves which form a thick carpet on the ground, weeds do not constitute a problem.

SUGAR

The most important insect pests on sugar in Pernambuco include :—

Margarodes carvalhoi Costa Lima.
Diatraea saccharalis Fabr. (potential) (also in Sergipe).
Ligyrus bituberculatus Palisot de Beauvois.
Ligyrus humilis Burm.
Trionymus sacchari Ckll.
Nematoda.

Margarodes carvalhoi, a mealy bug, lives on the subterranean root system of the sugar-cane. Apart from the loss of sap due to its feeding, the saliva of this species is highly toxic, and causes a severe necrosis of the roots, known in Pernambuco, as " Sugar Foot Rot." Heavy losses are reputed to be caused by this organism, and an efficient and cheap control is eagerly awaited by everyone concerned. A mixture of dichloropropane and dichloropropene (DD) is effective, but much too expensive to treat very large areas. This material, at 400 lb. per acre had been tried by the staff of the Sugar Experimental Station with excellent results, but cost prohibits its use.

Diatraea saccharalis is too well known to merit description here. It is, at the moment, not a very serious problem in Pernambuco, although it is a major factor in the adjacent state of Sergipe, and in the South. It seems probable that Pernambuco will eventually be invaded on a large scale, but at present this lepidopteron is adequately checked by the biological control exercised by *Trichogramma minutum*, *Paratheresia claripalpis* (*signifera*), and *Microbracon* spp. It is worth noting, however, that the use of BHC, DDT and 2,4-D elsewhere has, in some cases, increased the build-up of *Diatraea saccharalis* by exterminating its parasites, and this should be borne in mind when contemplating the use of these materials in sugar-cane.

Ligyrus bituberculatus and *humilis* both attack the sugar-cane after planting, boring into the stem. In the case of *bituberculatus* the larval stage is the most important, whereas with *humilis* it is the adult which

Plate 1.—Clean Bananas after Spraying with 'Perenox' (Brazil).

Plate 2.—A well tended Citrus Plantation, which has been routine sprayed with 'Albolineum' and Parathion (Brazil).

Plate 3.—Tobacco Seedlings of a Cigar Variety growing in the shade in Bahia.

Plate 4.—Sound fruit of coffee dusted with 'Agrocide' 1 against the coffee berry borer.

causes the major damage. Normally they only attack underground, but sometimes the adults of *bituberculatus* will gnaw the stem above soil level. The borings of these insects permit entry of fungal pathogens besides the direct damage caused, and many setts are totally destroyed where these beetles are prevalent. These species are only a problem on low-lying lands with humid soil conditions, but when present in numbers can cause serious losses.

The usual control measures adopted include trapping the flying adults by means of a powerful light, and injecting the soil with carbon bisulphide. Neither of these operations seems very successful, and it has been suggested that trials be carried out with BHC as a soil insecticide at rates equivalent to 40—60 kilograms per hectare of 'Agrocide' 2. Parallel tests should be run with a combined BHC/mercurial dressing at rates to be determined.

Attacking the 'setts' almost immediately they are planted is the Pseudococcus *Trionymus sacchari*, resulting in weakly shoots on emergence. No control measures are adopted to combat this species, but results should be obtained in conjunction with the trials previously suggested.

Nematodes, mainly *Heterodera marioni*, are a problem, and no feasible control is yet known in sugar-cane, other than the too expensive DD mixture.

All plantations in Pernambuco are heavily infested with weeds, mainly grasses, the principal pests being *Panicum* spp. and *Cyperus rotundus* (the latter not, of course, a *true* grass). Some of the farms employ a hundred men three times a year for weeks at a time hand-weeding, and are eager to reduce such labour costs if at all possible. The use of 2,4-D formulations as pre-emergence weedkillers is under trial and results are awaited with interest.

MANGO

Mangos in Pernambuco are heavily attacked by the fungus *Diplodia recifensis*, introduced by the coleopteron *Xyleborus affinis*. This beetle has slight, spade-like expansions on its tibia, with which it carries spores and small pieces of hyphae of *Diplodia recifensis* into the tunnels which it bores through the trunk. The insect does not consume wood, but lives entirely off the fungus which it propagates on the faces of its galleries. Due to reduced oxygen tension within the borings, and continual cropping by *Xyleborus*, the fungus produces no pycnidia.

Diplodia recifensis usually kills the mango tree in two years or so, and some 120,000 trees are estimated to die every year from this fungus. Once *Diplodia* has gained entrance to the cambium, the tree is doomed. The only possible line of attack is against *Xyleborus affinis* before it starts boring.

Practically every chemical has been tried against this beetle in small-scale Experimental Station trials, except parathion, with no success. Trials with parathion are now in progress.

COCONUT

The main coconut pests are :—

Rhynchophorus palmarum Sabi — Coleoptera
Rhina barbirostris Fab — Coleoptera
Homalinotus corcaceus Gyll — Coleoptera
Aphelenchoides cocophilus Cobb — Nematoda.

The beetle *Rhynchophorus palmarum* does considerable damage both in the larval and adult stages, devouring the upper parts of the palm, and boring into the more succulent portions of the leaf stems and central shoot. More important than this direct damage, however, is the transmissions of the Nematode, *Aphelenchoides cocophilus*, which causes 'Red Ring Disease,' a most serious infection, and responsible for the death of many thousands of trees each year.

'Red Ring Disease' is known, of course, in Trinidad, British Honduras, Panama, Venezuela and Costa Rica, but it has only recently been shown that the nematode is frequently transmitted to uninfected trees by *Rhynchophorus palmarum*. Of many thousands of larvae dissected, in every case *Aphelenchoides* was found swarming in the intestinal tract. Not only is the eelworm introduced into the green plant tissues by direct feeding of the larvae, but it is expelled with the faecal pellets which fall to the ground, the nematode then gaining entry *via* the root system. Trees so infected die within four years.

The external symptoms in the tree include excessive wilting and drooping of the foliage at the apex, and, as time passes, the lower green stems start to lose their natural turgidity and droop, eventually dying back altogether. If the tree be sectioned, a broad reddish-brown ring of what looks like fungal stain is evident, cutting the medullary rays at right angles, and extending to a complete circle. The whole length of the trunk is similarly affected.

At present there is no control against *Rhynchophorus palmarum*, although DD has been found an efficient nematocide against those eelworms living free in the soil. If the only mode of nematode entry was *via* the roots, even DD would be an economic measure—but it is of little use whilst *Rhynchophorus palmarum* can transmit infection from above. BHC and DDT are useless against this beetle and nicotine sulphate has little effect. Parathion, as 'Rhodiatox,' has been tried, to no avail. Some control is given by arsenical dusting, but to no great extent. Research is required to overcome this problem.

Rhina barbirostris is another pest of considerable importance. Unlike *palmarum*, it attacks the harder, more mature parts of older trees. Eggs are laid in excavations in the bark, and the larva, which lives for four or five months, burrows directly into the wood of the trunk. Its galleries cut the main circulatory vessels, and sap flows out of the entrances of the borings and trickles down the trunk of the tree. As many as five thousand holes have been found on one tree, all holes releasing not inconsiderable quantities of sap. The effect on the tree is only too evident.

Through ignorance some of the smaller farmers light fires at the base of their coconut trees in order to hasten fruiting. In consequence, the bark for about four or five feet from ground level is charred—*Rhina barbirostris* is particularly fond of selecting such sites for oviposition.

Due to the habits of the larvae, the application of insecticides is impracticable, and the adults collect in the top parts of the palm. The remedy employed to date (not very successful), is to poke a wire into a fresh boring, thus crushing the larva inside. As, after feeding for about three months, the larvae stop up the entrances with sawdust and the holes become invisible, it can be imagined how many are missed in the upper portions of the trunk.

CITRUS

The main citrus pests include :—

Ortezia prolonga
Anastrepha spp.
Phyllocoptes oleivorus
Aphis citri (Black form)
Pseudococcus comstocki (aerial form)
Diaphorina citri
Leptoglossus spp.
Frankliniella spp.

Particularly good control of scales and mealy bugs has been found using 'Albolineum' at the recommended concentration with the addition of 150 c.c. ' Fosferno ' Liquid to each 100 litres of mixture. The consensus of opinion, shared by the writer, is that the parathion does the killing, the 'Albolineum' aiding penetration.

COTTON

INSECTS—The most important insects attacking cotton include :

Gasterocercodes brasiliensis Hambl.
Aphis gossypii Glover.
Horcias nobilellus Berg.
Platyedra gossypiella Saunders.
Alabama argillacea Hubn.

Gasterocercodes brasiliensis.—This insect is a major pest of the younger cotton plant. Generally the full grown plant is resistant. The beetle is found on a great number of intermediate host plants and is not by any means confined to cotton. The beetle invades the cotton areas from the surrounding vegetation and first attacks when the young cotton is between 8 and 10 cms. high. The adult attacks the stem near ground level. laying its eggs in the damaged portion, the resulting larvae later boring into the stem and the upper part of the root system. Attacked plants wilt and generally die.

Losses due to this beetle range from 20 to 50%.

Aphis gossypii.—This aphid is also not confined to cotton, but exists on many other host plants in the field. It propagates extremely rapidly and in some years, particularly dry ones, becomes a pest of considerable importance.

Horcias nobilellus.—This flea hopper, together with its allies *Colocris stigmosus*, *Garganus gracillentus*, *Creontiades rubrinervis*, *Psallus* and *Lygus* spp., is a very important pest, but the intensity of attack fluctuates from year to year. This complex, both in the adult and larval stages, sucks the sap of the plants from the stem terminal buds and the smaller ' squares,' causing shedding of ' squares,' young bolls, and in many cases the dropping of flowers. The physiological reaction of the plant to this attack is a noticeable increase in growth, and invaded cotton is invariably taller and more spindly than healthy plants.

Attack generally starts sometime in December and by the middle or end of the following month a very considerable population exists, and it is at this time that control measures should be instituted, in order to avoid a still heavier build up in February and March.

If no control measures are taken at the times stated, the damage to cotton in the months of February and March is tremendous. It has been estimated that in bad years the total loss of crop, due to this complex, is in the region of 50%.

Platyedra gossypiella.—The pink boll worm varies in importance from year to year, but in bad years builds up to alarming proportions, notwithstanding the fumigation of the seed with methyl bromide. The life history and damage caused by this insect are very well known.

Alabama argillacea.—The cotton leaf worm does not over-winter in São Paulo, as far as can be ascertained, and its activity varies greatly year by year, but when a large invasion takes place, the greatest damage is done during the months of January to March. In some years, this moth causes nearly as much damage as the flea hopper.

Control.—As is well known, the cotton complex is adequately controlled by a combined dust of gamma-BHC, DDT and sulphur, in the proportion of 3:5:40, applied at a rate of between 15 and 20 kilos per hectare. BHC sprays are also successfully used and recently extremely good control against *brasiliensis*, *argillacea*, aphid and red spider, has been obtained by the use of parathion, mostly as 'Rhodiatox,' although some 'Fosferno' has been sold for this purpose. 'Fosferno' Liquid 20 should be used at a concentration of 30—50 c.c. in 100 litres of water.

The official recommendations of the Biological Institute, São Paulo, include toxaphene, 5% parathion at 0.5%, and BHC, DDT, sulphur mixtures as dusts, and also toxaphene 40% at 350 grms. per 100 litres of water or 200 grms. to 100 litres of water, or a parathion 5% emulsion, or BHC 6% 500 grms. to 100 litres of water as sprays, all at a rate of 800—1,000 litres per alqueire.

TOBACCO

INSECTS.—The following insect pests attack tobacco in Bahia :—

Isotoma palustris	— Springtail (Collembolid) —	Seed beds
Prodenia latifascia	— Lepidoptera —	growing plant
Prodenia ornithogalli	— „ „	„
Plusia nu	— „ „	„
Feltia annexa	— „ (cutworm) „	„ and seedlings
Heliothis armigera	— „ „	„
Protoparce sexta	— „ „	„
Agriolimax agrestis	— „ (leaf miner) —	growing plant
Diabrotica speciosa	— Coleoptera —	growing plant
Epitrix parvula	— „ „	„
Epitrix cucumeris	— „ „	„
Engytatus notatus	— Hemiptera — „	„
Engytatus geniculatus	— „ „	„
Schistocerca cancellata	— Orthoptera — „	„
Xyleus angulatus	— „ „	„
Omexecta servillei	— „ „	„
Dichroplus punctulatus	— „ „	„
Orphulella punctata	— „ „	„
Heterodera marioni	— Nematoda — root system.	

The most important of these pests are *Isotoma palustris*, *Prodenia* spp., *Plusia nu*, *Heliothis armigera*, *Diabrotica speciosa*, *Epitrix* spp., and *Heterodera marioni*.

At the Tobacco Experimental Station the writer saw seed beds heavily damaged by *Isotoma palustris*, the first damage of this type noticed in South America. The leaves were badly punctured on either side of the mid-rib, and showed a necrotic area spreading outwards to the edges. The lower seedling leaves were chlorotic and wilting and obviously the saliva of this species is toxic. About 80% of the seedlings seen were affected. One seed bed alone seemed to be free of attack, and during discussion it was elicited that the clean bed had been sprayed with 'Rhodiatox'. The interesting point was that so had three of the other seed beds which were badly damaged.

Trials have been suggested for the control of this pest with 'Fosferno' at 0.002% concentration active ingredient and BHC at 0.26% gamma isomer as dusts at a rate for each insecticide equivalent to 35 kilograms per hectare, and with 'Agrocide' Smoke Generators No. 23 at one generator to 220 cu. metres in seed beds with concrete surrounds and top shade.

Trials have also been suggested with 'Agrocide' 7 at 60 kg. per hectare, placed around the plants, against *Prodenia* spp. and *Plusia nu.*, and with DDT 5% dust at approximately 8 kilograms per hectare against *Heliothis*.

As far as could be ascertained little had been done in the way of controlling *Diabrotica speciosa* on tobacco, even though considerable damage was regularly perpetrated by this coleopteron. It has been

suggested that trials be instituted using DDT at 0.1% as a spray, as this method of control has been used successfully in Brazil on other crops.

Epitrix parvula is adequately controlled by the use of a 50% DDT wettable powder used at 0.2%, but the results of trials using 'Gamerial' 1, 'Agrocide' 1, 'Agrocide' Wettable Powder, should be followed up with interest.

Heterodera marioni is a great problem on tobacco, and on many Brazilian crops, and does a very great deal of damage. Many materials have been tried, but only DD has been found successful. This product is too expensive for large-scale use, and there is a crying need for some cheap control method.

FUNGI.—The main fungal diseases found in Bahia on tobacco include :—

Rhizoctonia solani
Perenospora tabacina
Alternaria spp.
Cercospora spp.
Bacterial and virus diseases.

Perenospora tabacina occurs in the seed bed, and is adequately controlled by 'Fermate' as a 0.3% water spray. Trials were suggested, using 'Perenox' at between 500 and 600 grams of product per 100 litres of water (and, if so desired, combined with a seed-bed insecticidal spray).

Except in the bigger plantations nobody seemed in the least concerned about reduced crop yields of up to 10—15% out in the field from *Alternaria* and *Cercospora*. 'Perenox' has been strongly recommended, but until the smaller man has been convinced that it will be more profitable for him if he plants a double acreage and reaps the benefit from 95% of that double acreage instead of planting twice what he needs and handing over the other half to pests and diseases, the introduction of control measures will be a slow process.

Most of the crops seen were heavily infected with Tobacco Mosaic Virus. At a certain stage of growth the growing shoot is nipped off between the fingers, and a couple of operators can transmit the virus to a whole field in a very short time. It has been shown that a large proportion of the cigarettes smoked in Brazil carry the active virus, and workers who smoke in the tobacco plantations are also responsible for virus transmission. The virus is transferred from the cigarette to their fingers, and from thence to the plant on which they happen to be working. To this must be added insect transmission, and it will be appreciated why the Institute put the figure at well over 50% of all tobacco being diseased.

It has been estimated that the smaller grower could not only grow better quality tobacco, but increase his final yield by as much as 35—50% by using modern pest control methods.

PINEAPPLE

In São Paulo, Rio de Janeiro, and further north, the mealy bug (*Pseudococcus brevipes*) was found wherever pineapples were planted in any large numbers. Large colonies were discovered situated on the basal, subterranean portion of the leaves, and rarely on leaves growing well above the ground. Observations would lead to the belief that *Pseudococcus brevipes* exists in biological association with ants (*Solenopsis* spp.) as, in most instances, the two were found together.

Many plants showed symptoms of Mealy Bug Wilt in the form of weakly growth and a characteristic green spotting of the leaves.

According to the Experimental Station near Rio, ' slips ' are frequently attacked by *brevipes* within a few days after planting. Even when heavy attacks are manifest, Mealy Bug Wilt, transmitted by *brevipes*, seems unable to gain a hold on plants growing in virgin fertile, heavy soils, but is extremely evident in poor, sandy regions.

Practically all chemicals have been tried at one time or another without success, and the official authorities are now concentrating on biological control methods. Certain species of *Pseudophycus* are efficient parasites, but only attack the mealy bugs living on the leaves above ground.

The pest of greatest economic importance to pineapples is undoubtedly a butterfly larva of *Thecla* sp. The caterpillars damage the fruit and skeletonise the leaves, sometimes living as true leaf miners. Lead arsenate is used to combat this insect, and trials are now being run with various formulations.

COFFEE

INSECTS.—The following insects attack coffee in São Paulo, but not all are of great importance.

Heliothrips rubrocinctus Girad	— *Thrips*	— Leaves
Carineta fasciculata Germar	... *Cicadidae*	— Roots
Metcalpiella pertusa Germar	— *Membracid*	— Stems
Aleyrodes albescens Hempel	— *Aleyrodid*	— Leaves
Alecanochiton marquesi Hempel	— *Coccid*	— Leaves
Eriococcus coffeae Hempel	— *Coccid*	— Branches
Pseudococcus citri Risso	— *Coccid*	— Roots
Pseudococcus cryptus Hempel	— *Coccid*	— Roots
Saissetia hemisphaerica Targ	— *Coccid*	— Stems
Howardia biclavis Comst	— *Coccid*	— Stems
Coccus viridis Green	— *Coccid*	— Stems
Eacles magnifica Walk	— *Lepidoptera*	— Foliage
Mocis repanda F.	— *Lepidoptera*	— Foliage
Auximobasis coffeaella Busck	— *Lepidoptera*	— Fruits, Seeds
Macrodactylus suturalis Mann	— *Coleoptera*	— Flowers
Pantomorus godmani Crotch	— *Coleoptera*	— Leaves
Stephanoderes hampei Ferr	— *Coleoptera*	— Fruits
Ceratitis capitata Wied	— *Diptera*	— Fruits
Anastrepha fratercula Wied	— *Diptera*	— Fruits

Atta sexdens L
Atta laevigata SM
Acromyrmex octospinosa RH
Acromyrmex subterranea Forel — Ants — Foliage
Acromyrmex nigra SM
Acromyrmex aspersa SM

The following nematodes also attack the coffee roots :—
Heterodera radicicola Greef
Tylenchus coffeae Z
Diploscapter rhizophilus Rahm.

Stephanoderes hampei.—So much has been written on this most important insect that a full description is not necessary here. Suffice it to say that this beetle lays its eggs in the developing fruit or bean, and sometimes in other fruits attacked by the species. Hatching takes 3—14 days, and sometimes longer, according to the prevailing temperature and humidity. The newly hatched larvae immediately start gnawing the fruits, turning them into a fine dust in 10—20 days. Within 28—50 days the pupal stage is reached, and lasts some 6—11 days, when the adults emerge. The complete cycle varies between 34 and 62 days. Females are fertilized within the fruits in which they were hatched, and fertilization takes place about four days after reaching the adult stage.

Coffee is attacked during all stages of its maturity.

Some idea of the spread of this pest may be gained when it is stated that, in São Paulo, some 14,000 properties are affected, totalling many millions of coffee trees

Adequate control is given by the application of 45 kilos of 2% BHC per 1,000 trees. Two or three applications are necessary. Together with chemical control should be practised fazenda hygiene, and all fallen berries after harvest should be collected and destroyed. Treatment is expensive, but at the moment prices are high, and the crop can stand it.

BANANAS

The banana is grown almost everywhere except in the most southern section of Brazil and in the high altitudes subject to light freezes. Some idea of the industry may be gauged by the fact that it is estimated that a hundred million bunches of bananas are produced in Brazil each year, and undoubtedly the country ranks as one of the leaders in world production of this fruit.

Notwithstanding the many thousands of hectares planted with banana, insect pests are not of great importance. Occasionally plants are stripped by undetermined gregarious lepidopterous larvae, but this is rare.

The only pest worth mentioning seems to be the fungal pathogen, *Cercospora musae*. 'Perenox' at 250—300 grams per 100 litres of water gives good control of this disease, and there would seem to be great scope for the use of this product in the banana growing regions round Santos and São Paulo and the low-lying flats in Rio de Janeiro state.

ANTS

These insects constitute probably the greatest menace to agriculture in Brazil. No crop seems to be immune. These ants are of the leaf-cutting variety and include :

Atta sexdens
(v. *rubropilosa*, *robusta* and *bisphaerica*)
Atta cephalotes
Atta laevigata

The first named species is the one of most importance in the State of São Paulo.

Atta species of ants belong to the tribe *Attini*, which is confined to sub-tropical and tropical America, and all are leaf-cutters.

According to Imms all *Atta* species are fungus-growers and fungus-eaters. The fungi are cultivated in special chambers of the nest, and are usually referred to as 'fungus gardens,' and are practically pure cultures of the fungi concerned, being assiduously weeded and tended by the ants. Neither free aerial hyphae, nor any form of fruit body normally develop. In appearance a fungus garden is a sponge-like mass of leaf-fragments or, in some cases, insect excrement. The fungi grow rapidly on this substratum and produce numerous swellings or excrescences, and it is these which form the food of the ants and larvae.

The systematic position of these fungi is still not certain; several genera have been described which have been referred to the *Ascomycetes* and *Basidiomycetes*.

The formation of a new fungus-garden is always undertaken by the queen, who, before departing for the nuptial flight, fills her infrebuccal pocket with active fungal hyphae. This collection is expelled within the newly-made nest chamber, and the growing hyphae are nourished, at first by the faeces of the insect, who may even sacrifice some of her eggs for this purpose.

All the usual castes are found among the *Atta* ants, males, females, workers, soldiers, and these may be termed normal phase castes. Together with this normal phase may be found aberrant or pathological types, including dwarf forms known as *phthisaners*, giant males or *dorylaners*, males which closely resemble females or *gynaecaners*, aberrant or beta-females, and the peculiar egg-laying worker.

These ants cause a considerable amount of damage in all tropical and sub-tropical American countries. Besides the major attack on certain crops, shade trees, and ornamentals for the purpose of obtaining the leaf-fragments already referred to, certain species (*A. lundi*) sometimes undermine dwellings and other buildings.

Ants carrying leaf and stem fragments back to the nest have been observed traversing a tortuous path over 200 metres of rough ground. Frequently three or four paths are used simultaneously by different sections of the same community, the entrance tunnels being unequally spaced around the base of the nest.

Considerable success has been achieved elsewhere by the use of methyl bromide. It is an ideal ant killer, but, in its present form, is not easy to administer apart from its poisonous nature. Carbon bisulphide also gives excellent results when properly applied but, here again, it is relatively difficult to apply and is, of course, highly inflammable and explosive.

It has been shown that parathion is lethal to ants, exerting, as it does, both contact and fumigant action. Success has been achieved with liquid and smoke formulations in all cases except where peculiar nest construction prevents the distribution of the insecticide below ground. Nests up to 200 sq. ft., apparent surface area, were treated with from 1—6 generators per nest, while ' Fosferno ' Liquid 20 was used at concentrations equivalent to 10, 20, 30, 40 and 50 cubic cms. ' Fosferno ' Liquid 20 per 100 sq. ft. in from 1—4 litres of water. TEPP was used at equivalent concentrations, assuming that 100 cubic cms. was equivalent to 30 cubic cms. of ' Fosferno ' Liquid 20. Parathion is probably the most effective insecticide so far tried in this field, and intensive experiments are continuing in Brazil.

It has to be borne in mind that carriage of water is a serious problem in the interior of Brazil and, unless the " carrier " can be reduced to a minimum, liquid preparations will probably have to be ruled out solely on account of transport.

'AGROCIDE' COTTON DUSTS

By F. G. ORDISH

IN 1948 a small booklet from the Commonwealth Institute of Entomology was published, entitled 'List of Recorded Cotton Insects of the World,' by H. Hargreaves. As its title implies, it records the names of all the insects so far found on cotton, the total number being 1,330.

Although some growers may think they have all the pests, in practice, in any one area, there will only be a few major pests of the cotton crop. Cotton has always been a crop very susceptible to insect attack. The modern use of insecticides dates from the employment of arsenicals to treat the cotton crop.

In the late 19th century in the southern United States 'King Cotton' was threatened with a much bigger source of potential loss than the abolition of slavery. This threat was the bollworm and boll weevil. These pests were eventually controlled by the application of arsenicals, lead and calcium arsenates. They were applied first as sprays, and later as dusts.

These products were found over the years to have certain disadvantages. Firstly, they were very poisonous to man, and they were slow acting stomach poisons. The insects had actually to eat a treated part of the plant in order to absorb a toxic dose and be killed. Secondly, the treatment with arsenicals tended to bring on an attack of aphis late in the season which the arsenicals were powerless to control. Furthermore, red spider was very little affected by arsenicals.

The development of the synthetic chlorinated insecticides during the war has opened a new chapter in the control of cotton insects. DDT is a powerful insecticide against the bollworm, and benzene hexachloride is absolute death to the ravaging boll weevil and the leafworm (*Alabama argillacea*). Both these insecticides are both stomach and contact poisons, that is, they kill by the insect feeding on the leaf and also by the insect being touched by the insecticide.

The mixture of these two products consequently gives a very powerful weapon against cotton pests ; moreover, the use of a product made from mixed insecticides overcomes any latent tendency to breed a race with a resistance to a given insecticide. For instance, the wholesale use of DDT in the U.S.A. against house flies has bred out a race resistant to it. The same thing might happen with cotton insects, though not so quickly, but it is greatly minimised by the use of mixed insecticides, because although DDT and BHC are specific for particular pests, they are not without a considerable action against the others. BHC, for instance, whilst put in the product to kill the boll weevil, does have a considerable effect against the bollworm.

The use of the combined BHC/DDT insecticide overcomes the difficulty of the build-up of aphis infestations experienced when arsenicals alone are used, but if red spider is a problem, BHC and DDT alone may not be sufficient. It has been found, however, that the addition of dusting sulphur to the mixture adds a control of this last pest with scarcely any addition to the price.

This brings us to the modern insecticide, 'Agrocide' Cotton Dust, composed of benzene hexachloride, DDT and sulphur. This product has been used in all the major cotton producing countries last year with great success and is now very much in demand, particularly in Egypt, where it has proved the best method of control of *Prodenia*.

It is not sufficient, however, to have the right insecticides in the product. The product must also be in the right form for application, that is, it must dust well through the machines available for the purpose. Such machines, it will be realised, may vary from a cotton bag hit with a stick and the dust sprinkled over the plant to the hand operated fan driven machines, from bellows to modern power driven dusting machines, and finally to aircraft. For this reason, we offer 'Agrocide' Cotton Dust in a number of different forms, the proportions of insecticides varying, and different types of fillers being used to give a range to suit all conditions. The 'Agrocide' Cotton Dusts are as follows :—

	Per cent.		
	Gamma BHC	DDT	Sulphur
'Agrocide' Cotton Dust 3:5:40 (Light)	3	5	40
„ „ „ 3:5:40 (Medium)	3	5	40
„ „ „ 3:5:0 (Medium)	3	5	none
„ „ „ 3:10:40 (Light)	3	10	40
„ „ „ 3:10:40 (Medium)	3	10	40
„ „ „ 3:10:0 (Medium)	3	10	none

It will be noted from the above table that 'Agrocide' Cotton Dusts are offered with high and low proportions of DDT, with and without sulphur, and on light and medium fillers. Thus, a grade can always be found to suit a particular pest problem.

The scheme of dusting must, of course, vary according to the season, but in general it will be at the rate of 10 lb. per acre at 4 or 5 day intervals until the insects are under control. Where bollworm is bad, the higher proportion DDT cotton dusts must be used, and the rate of application may have to be increased to 15 lb. per acre.

It will also be noted that there is a distinction in the dusts between light and medium. This refers to the fillers used. The light dusts are more suitable for use with hand machines, and the medium dusts are better for power driven machines and aircraft.

TECHNICAL BREVITIES

This section includes information on plant protection problems in their widest sense which has been obtained from reports received from our overseas representatives, to whom we have pleasure in making acknowledgment, and from published literature. Wherever the latter source has been employed, we have given the reference to the publication concerned. We have to repeat our expression of indebtedness to the Heads of Jealott's Hill and Hawthorndale Laboratories (I.C.I.—Central Agricultural Control) for permission to make use of abstracts from literature prepared by their staffs.

INSECTICIDES

Wireworm Control: Maize Seed Treatment

In laboratory and field trials parathion applied to maize seed at 4 and 8 oz. of 50% dust per bushel was highly toxic to wireworms. The treated seed germinated earlier and growth in the field seemed to be accelerated. BHC on the seed gave some protection, especially on lightly infested land.

The corn wireworm, *Melanotus communis*, and *Dalopius pallidus*, were the predominant species.

Dogger, J. R. and Lilly, J. H., J. Econ. Ent. 1949, 42 (4) : 663-5.

Cereal Leaf-Miner Control

In Cyprus, the tineid leaf-miner, *Syringopais temperatella*, a serious pest of cereals, is effectively controlled by BHC or DDT. Treatment consists of (1) broadcasting BHC on the soil at sowing time, so that it is mixed in when the seed is covered, using 4.2 oz. gamma isomer per acre, or (2) dusting plants after attack has started, using BHC at the above rate or 5% DDT at 42 lb. per acre, or (3) applying sprays containing per 100 gall. either 2.6 oz. gamma BHC or 39 oz. of 20% DDT Wettable Powder at the rate of 90 gall. per acre. Kill is probably by contact during larval migration from leaf to leaf. DNOC spray, which is also effective, seems to act on the larvae in their mines.

Morris, H.M., Nature : 1950, 165 (4197) : 573-4.

Olive Scale Control

Parathion gave promising control of olive scale (*Parlatoria oleae*) in preliminary trials of olives and peaches. It was particularly effective against eggs and young scale. It was slow to act on adult females, but delayed oviposition and probably reduced the number of eggs laid. Spring sprays gave the best results. Winter sprays and spring and

summer dusts were unsatisfactory, although two summer dustings gave excellent control of black scale (*Saissetia oleae*).

Stafford, E. M., J. Econ. Ent., 1949, (42), 4 : 656-60.

BHC Taint

In Carolina potatoes grown on land that had been treated against wireworm up to 0.4 lb. gamma-BHC per acre showed no off flavour.

Kulash, W. M., J. Econ. Ent., 1949, 42 (4) : 705-6.

Corn Rootworm Control : BHC Persistence

In Nebraska, U.S.A., it was demonstrated that soil treatment with 1 to 2 lb. gamma-BHC per acre, applied as a spray to the surface just before discing and planting, will control corn rootworms (*Diabrotica spp.*) for at least two seasons.

Muma, M. H., et al., J. Econ. Ent., 1949., 42(5) : 822-4.

White Grub Control : BHC Persistency

In Queensland BHC gives cheap and complete protection of sugar cane against the grey back cane beetle (*Dermolepida albohirtum*), the worst pest of cane in Queensland. Best results are obtained by applying BHC dust to plant cane in a band 15-in. wide along the furrows after the cane has germinated and just before the soil is turned back over the stool. If the plant crop has not been treated, ratoons can be protected by ploughing away from each side of the row and applying the dust in the drills as formed.

Growers are advised to use a 20% BHC dust on a pyrophyllite-rock phosphate base at rates per acre of 50 lb. for a single crop, 62½ lb. for a plant and a ratoon crop, and 75 lb. for a plant crop and two ratoons (normal practice in North Queensland), which assures protection over the complete cycle. Treatment commonly increases yield of plant cane by 8 to 10 tons per acre, and strikingly improves growth of following ratoons.

Mungomery, R. W., Cane Grower's Quart. Bull., 1950, 13 (4) : 160-4.

Sand Wireworm Control

In Louisiana complete protection of maize from the sand wireworm (*Horistonotus uhlerii*) was obtained by soil treatment with BHC at dosages as low as 2 oz. gamma-BHC per acre. Row treatment just before planting, and drilling with sand or complete fertilizer were satisfactory. Second season crops were protected.

Floyd, E. H., J. Econ. Ent., 1949, 42(6) : 900-3.

BHC Phytotoxicity to Cereal Seedlings :
Breakdown Products as Weedkillers

In Alberta, Canada, experiments in seed dressing of wheat with various preparations and constituents of BHC show that distortion of seedlings which occurs at doses of 0.2% gamma-BHC on seed

weight—the maximum recommended for wireworm control—is not due to the gamma isomer or any major constituent of BHC. Use of a deteriorated sample of BHC resulted in more severe deformation, suggesting that a breakdown product, such as trichlorobenzene, may be the cause. 2,4-dichlorophenol, which may be produced by the breakdown of BHC, also caused deformations.

The possible use of these materials as selective weedkillers is under investigation.

Hocking, B., Sci. Agric., 1950, 30 (5) : 183-93.

Strawberry Root Weevil Control

J. C. Shread of Connecticut Agricultural Experiment Station reports complete kill of strawberry root weevil (*Otiorrhynchus ovatus*) by BHC or chlordane in low doses.

Agric. Chemicals, 1950, 5 (4) : 52.

Tineid Wheat Leafminer (*Syringopais temperatella*)

In three trials in Cyprus 'Agrocide' 2 at 150 lb. per acre and 'Agrocide' 3 at 42 lb. per acre gave good control of this pest, resulting in an increase in grain yield of 40% on infested land after treatment.

Paddy Grasshopper (*Hieroglyphus banian*)

Good control of this pest was obtained in India by dusting with 5% BHC dust at 20—25 lb. per acre on the appearance of the nymphs.

Cabbage Root Fly (*Chortophila brassicae*)

Good control of this pest was obtained in Holland by the application of 'Agrocide' 3 dust to the base of plants at 5 grams per plant (150 kg. per hectare) after planting out in the field, and by treating seed beds at 150 kg. per hectare when the plants emerge.

Grasshoppers (*Chortiocertes terminifera*)

4% BHC in dieselene is recommended for the control of these insects in Australia.

Bait composed of 56 lb. bran, 1½ lb. 20% BHC in 5½ gallons of water is also used.

Apple Root Borer Control

Trials on the control of the apple root borer (*Baryopadus squalidus*) in Victoria have demonstrated that two 0.1% DDT cover sprays can give good control of the adults, and wire net skirts fastened round tree trunks and sprayed every three weeks with 0.1% DDT seem to be effective traps of the adult beetles, which ascend the trunks prior to egg laying. Soil treatment with 10% BHC at ¾ lb. per tree plus 1½ lb. sulphate of ammonia per tree is not toxic to emerging beetles, but was designed to kill larvae and its value cannot be assessed for at least four years, during which period of time the larvae feed on the roots of the trees.

G. T. O'Loughlin, J. Dept. Agric. Vict., 1950, 48 (1) : 35-8.

Melon Fly Control by Poison Baits

In South Africa sugar bait sprays containing parathion or BHC are promising against melon flies (*Dacus ciliatus* and *D. bivittatus cucumarius*), which make the economic growing of cucurbits hazardous, whereas the officially recommended sodium fluosilicate and lead arsenate give poor control. Flies taking baits containing the latter toxicants are able to lay eggs before they die, but parathion and BHC cause paralysis too rapidly for this to occur. DDT is slower in action and phytotoxic. Preliminary trials indicate that either 0.005% parathion or 0.01% BHC in sugar solutions or 10% Golden Syrup is attractive and highly toxic to melon flies. Farmers are recommended to try ½ to 1 oz. of 15% parathion wettable powder in 3 lb. sugar and 4 gall. water sprayed as coarse droplets when flowers first appear and repeated every week and after rains. Parathion does not injure cucurbits.

Hopburn, G. A., Farming, S. Africa, 1950, 25 (287), 67-8.

Corn Borer Control

Parathion as a 2% dust at 40 lb. per acre and as a spray containing 2 lb. of 25% wettable powder at 150 gall. per acre, applied four times at 5 day intervals, respectively gave 99% and 97% reductions in population of the corn borer (*Pyrausta nubilalis*) on sweet corn. Ear yields were increased from 21% to 92% and 85% respectively. Residue on the kernels was 0.06 p.p.m., and on the foliage 0.17 p.p.m. from the spray and 0.11 p.p.m. from the dust. DDT was slightly less effective.

Neiswander, C. R. and Hibbs, E. T., Ohio Agric. Expt. Sta. Bul., 695: 1949 : 84.

Strawberry Virus Vector Control

An experiment in the United Kingdom demonstrated that after strawberry maidens were sprayed every fortnight from April to July with parathion, using a low-volume sprayer, no aphids were found on the plants in the following spring and there was little or no spread of virus. Results are reported as very promising.

Jones, C. H., Grower, 1950, 33 (14) : 668-9.

Meadow Eelworm Control by Parathion

Applied as a soil drench to meadow nematode (*Pratylenchus pratensis*) on infected boxwood plants in 5-in pots 25% parathion wettable powder at 2.5 grm. in 50 c.c. water was extremely effective in reducing nematode populations. Treatment of 4 grm. was phytotoxic and 8.5 grm. killed all plants. Nematodes in the roots of 14 year old boxwood was reduced by applying 1 to 2 lb. of the chemical within a 2.5 ft. radius round the trunks.

Tarjan, A. C., Phytopathology, 1950, 40 (1) : 27.

Leaf Eelworm Control by Parathion

In New York State spectacular control of chrysanthemum leaf nematode (*Aphelenchoides ritzemabosi*) was obtained by spraying at

7 day intervals with parathion wettable powder at 0.25 lb. active material per 100 gall. At one centre an infected-leaf count of 1296 was reduced to 1. Good control was given by parathion at 0.17 lb. per 100 gall. in emulsion form. Neither BHC, DDT, chlordane, TEPP, nor nicotine sulphate approached this degree of control.

Dimock, A. W. and Ford, C. H., Phytopathology, 1950, 40 (1) : 7.

Fruit Fly (*Trypetidae*)

In South Africa parathion bait sprayed on to the foliage gave best results against this pest. Application of the following bait was made once per week :—

1 oz. 15% parathion wettable powder,
3 lb. sugar.
4 gall. water.

Orchard Mite (*Bryobia* and *Tetranychus* spp.) **on Apples**

Results of trials in South Africa indicate that parathion is an effective summer spray for mite control. ' Fosferno ' 20 used at 0.025% product and a 15% wettable powder used at 12 oz. per 100 gall. water gave 88% and 89% control respectively at approximately 3 days after application. It is concluded that parathion should be applied at not less than 0.011—0.015% for *Bryobia* spp. applied at the 4—5 mite per leaf stage and for *Tetranychus* at the 3 mite per leaf stage.

Vine Snout Beetle (*Phlyctinus callosus*)

In South Africa this pest is controlled by a concentration of 2½ lb. 50% DDT Wettable Powder in 100 gall. of water applied to the trunks and arms of the vines. One gall. of solution was used per three vines applied by knapsack sprayer. One spray application of DDT Wettable Powder was found to be more effective than three applications of 5% DDT Dust.

Green Vegetable Bug Incidence in New Zealand

The green vegetable bug (*Nezara viridula*) is firmly established and spreading rapidly in the North Island of New Zealand. To check the pest spraying with ½ lb. actual DDT per 100 gall. is recommended.

Everett, P., N.Z.J. Agric., 1950, 80 (2): 145-6.

FUNGICIDES

Copper Fungicide Persistency

Experiments in the U.S.A. showed that on potato foliage copper fungicide sprays always gave higher initial residues than dusts, and spray deposits weathered slower than dusts.

Baskin, A. D., Phytopathology, 1950, 40 (1) : 2.

Peach Brown Rot Control : Post-Harvest Dip

Liquid lime sulphur was the only post-harvest dip tested that gave some control of peach brown rot in the package. Chlorine compounds enhanced colour but injured at high concentrations. Copper sulphate to 125 p.p.m. Cu. gave no control. Actidione at 5 to 20 p.p.m. was very injurious.

Henberger, J. W. et al., Phytopathology, 1950, 40 (1) : 12.

Potato Blight Control : U.S.A. Measures 1949

In the U.S.A. sprays which gave good results against late blight of potato in 1949 included Dithane, Parzate, tribasic copper, Bordeaux, fixed coppers (Basicop, ' Perenox ') and Dithane and Parzate plus zinc sulphate.

Miller, P. R. and O'Brien, M. J., Agric. Chemicals, 1950, 5 (2): 28-31, 73.

WEEDKILLERS

Selective Weedkiller Increases Maize Yields and Reduces Labour

Experiments to test the effect of the application of selective weedkillers on maize fields in South Africa have yielded the following information :—

The application of 3 lb. ' Fernoxone ' per morgen (2 acres) as a spray five to seven days after planting considerably delays the germination of certain graminaceous weed seeds without affecting in any way the germination of the maize seed. The weeds are thus prevented from emerging over the critical period when weed competition does the greatest damage to young maize plants.

One month after spraying, when the weeds have appeared, the land should be weeded once, which will be sufficient to give a good crop.

Pre-emergence treatment of maize with ' Fernoxone ' plus one weeding produced the same weight of grain as areas given four weedings but no weedkiller, and four times the weight of grain from areas which received no cultivation and no weedkiller.

Altona, R. E. and Mentz, N. J., 'Veld,' Cooper & Nephews, S.Af. (Pty.) Ltd., Johannesburg, XIII : No. 14 : *Winter Issue*, 1950 : 295-6.

Chemical Control of Lantana

Hormone weedkillers are now found to be preferable to arsenic as a means of killing the roots of lantana by swabbing cut-off butts or spraying regrowth after brushing, as they are non-poisonous to animals and humans, non-corrosive and do not kill grasses.

The use of ' Methoxone ' or sodium salts of 2,4-D results in good kills if old plants are brushed and sprayed when there is abundant and vigorous regrowth, as spraying very young shoots results in little downward movement of the hormone so that the roots may not be killed.

2,4,5-T formulations (either alone or in combination with 2,4-D) are more effective than 2,4-D alone, particularly on large uncut bushes. But as it is not possible to spray effectively large areas of dense lantana, and as 2,4,5-T is dearer than 'Methoxone' and salts of 2,4-D, the use of the latter two hormones is probably more economical.

The hormones should be applied to lantana in fine weather and preferably by means of power sprayers.

Easterbrook, B., Queensland Agric. Journal, Vol. 71, *Part* 1, *July*, 1950.

Selective Capacity of 2,4-D. Contribution towards the Control of Red Rice (Preliminary communication)

Experiments in the greenhouse and in the field (which are being continued) on the effect of different concentrations of 2,4-D on the germination of white rice compared with that of red rice indicate that white rice can tolerate concentrations which destroy red rice.

Naundorf, G. and Villamil, G.F., Notas Agron. Palmira, 1949, *Vol.* 2, 70-81 (*Agric. Expt. Sta. Palmira, Colombia.*)

Abstd. in Field Crop Absts., Vol. 3, *No.* 2, *Apl.*, 1950

2,4,5-T Hormone-Type Weedicide to Control Blackberry and Other Woody Plants

Experiments in New South Wales have shown that although 2,4-D alone does not control blackberries, it assists the action of 2,4,5-T, to which these plants are particularly susceptible. The recommended rates of application are :—

3 lb. of 2,4,5-T as an ester per acre, or 2 lb. of 2,4,5-T plus 2 lb. of 2,4-D per acre, both as esters, each diluted with 100-120 gall. of water, and applied as a fine spray to the canes as well as the leaves. Best results are obtained during the summer months.

Regrowth after the first treatment must be treated with a second application of weedkiller when the canes are 3 to 4 feet long. To allow the maximum translocation of hormone to the roots after spraying the bushes should not be burnt until they are dead.

It is hoped that 2,4,5-T weedkillers will be successful for the control of many other plants, especially trees and shrubs.

2,4,5-T is not intended to replace 2,4-D, but, alone or mixed with 2,4-D, it is recommended for the control of certain woody plants which are resistant to 2,4-D alone.

2,4-D is as effective as, or superior to, 2,4,5-T for controlling ordinary herbaceous weeds (other than grasses) and is cheaper than the latter.

Green, K. R., B.Sc., Agric. Weeds Officer. Agric. Gaz., N.S.W.: 61, *No.* 7, *p.* 341, *July*, 1950.

Control of Witch Weed (*Striga spp.*) in Sugar Cane

It was found in India that 100% aerial kill of *Striga* was obtained by the application of a 1% 'Agroxone' dust applied along the cane rows at 26 lb. per acre with a hand duster during the first flush of

the plant. The second and third flushes were considerably reduced on treated areas. Spraying with a concentration of 1 gall. liquid 'Agroxone' per 100 gall. of water also gives control of the aerial portions of *Striga* weed.

Nutgrass (*Cyperus rotundus*) in Coffee

Good control of this weed was obtained in Brazil by the use of 3-4 gall. per acre of liquid 'Agroxone' (10% material). The foliage died down in 14 days and re-growth was controlled by a second application. When the bulbil system was extensive through long establishment of this weed, it was found that only the upper layer of bulbils was killed.

The coffee plant has not been affected by 'Agroxone' when used at normal rates, even when the weedkiller was applied directly to the foliage.

Control of *Xanthium strumarium*

In India both young and mature plants of this species were killed by concentrations of 1 or ½ gall. 10% 'Agroxone' Liquid per 100 gall. of water. At least two sprayings during the season were required to control this weed owing to fresh growth of germinating seedlings.

GENERAL

Sudden Death Disease of Clove Control

Abandonment of the clove eradication scheme in Pemba was announced on 14th June. Felling of trees has proved to be too great and costly a task. Alternative methods of checking sudden death disease will be sought.

Crown Colonist, 1950, 20 (225): 517.